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Storage and Spanish Onion Trials 1992

BY DAVID E. HILL

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SUMMARY

In 1992, 15 cultivars of Spanish onions and nine cultivars of storage onions were grown at Windsor in a sandy terrace soil and at Mt. Carmel in a loamy upland soil. Half of each cultivar was grown from bare-rooted transplants and half from transplanted plugs. At Windsor, the average yield of 15 Spanish onion cultivars was 669 50-lb bags/A for bare-rooted transplants compared to 556 50-lb bags/A for transplanted plugs. At Mt. Carmel, the average yield of 15 Spanish onion cultivars was 368 50-lb bags/A for bare-rooted transplants compared to 331 50-lb bags/A for transplanted plugs. The root systems of the seedlings in plugs became root bound and early growth was delayed until the roots escaped the root ball. At Windsor, yield of bare-rooted Daytona and Oro Grande exceeded 1000 50-lb bags/A. Yield of Gringo, Hybrid Big Mac, Valiant, and Snow White exceeded the national average of 720 50-lb bags/A.

At Windsor, the average yield of nine cultivars of storage onions was 740 50-lb bags/A for bare-rooted transplants compared to 669 50-lb bags/A for transplanted plugs. At Mt. Carmel, the average yield of nine cultivars of storage onions was 536 50-lb bags/A compared to 449 50-lb bags/A for transplanted plugs. Yield of bare rooted Corona and Prince exceeded 1000 50-lb bags/A. Yield of Copra, Wolverine, Early Yellow Globe, and Sweet Sandwich exceeded the national average of 720 50-lb bags/A.

Ailsa Craig (22%) and Oro Grande (15%) had the greatest yield of colossal size Spanish onions. Yield of jumbo size Spanish onions exceeded 85% in bare-rooted transplants of Daytona, Gringo, Oro Grande, Ringmaker, Riverside, and White Keeper. Of the storage onions, Prince and Benny's Red had the greatest percentage of jumbo size (73%).

In storage, the Spanish onion cultivar Daytona remained dormant for 7 months and was found suitable for late winter and early spring sales. The remaining cultivars of Spanish onions had excessive sprouting losses but were suitable for fall and early winter sales. Among the storage onions, Copra and Wolverine had the least sprouting after 7 months. Treatment with maleic hydrazide (MH30), an antisprouting agent, increased the storage durability of storage onions, but not Spanish onions.

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Storage and Spanish Onion Trials 1992

BY DAVID E. HILL

The per-capita consumption of onions in the United States has risen from 9.9 pounds in 1970 to 15.2 pounds in 1992 (Unrein 1993). The annual production now exceeds 2.5 million pounds and places onions fourth among all vegetables (Anon 1991). They are available year-round because of their capability of long-term storage supplemented with winter-grown crops from Texas and Mexico.

Onions are divided into sweet Spanish types whose bulbs grow to 3-5 inches and the smaller storage types that grow to 2-3 inches whose more pungent taste is abated by cooking. The bulbs of both Spanish and storage types are yellow, white, or red.

Historical perspective. The recorded history of onions (*Allium cepa*) dates back to 3200-2800 BC where they were found in Egyptian tombs. Onion culture spread to India, and then throughout the Greek and Roman empires about 400-300 BC. By the beginning of the Middle Ages, they had spread to northern Europe (Yamaguchi 1983). Onions were grown in colonial Connecticut with commercial production developing in Wethersfield, Southport, and Westport during the Civil War (Jenkins 1925). Several cultivars, Wethersfield Red, Southport Yellow Globe, Red Globe, and White Globe, were naturally selected by Connecticut growers and remain in commercial production.

Current outlook. The relatively recent rapid growth of the food service industry, which encompasses fast-food chains, school and corporate cafeterias and hospitals, has created a large demand, especially for Spanish onions. A price advantage in late summer and early fall develops before western-grown onions reach the market in October, and creates a profitable opportunity for Connecticut growers.

In 1990 and 1991, I tested up to 16 cultivars of Spanish and storage onions for yield, quality, and storage durability (Hill 1992). In 1992, to assure maximum bulb growth with subsequent harvest in September, I grew onions using plugs to eliminate transplant shock that often accompanies bare-

rooted transplants. Since storage durability of onions, a highly desirable trait, can be prolonged with an antisprouting agent, I tested its effect on the cultivars selected from earlier trials supplemented with several new ones. I report the yield and quality of onions produced by bare-rooted and plug transplants and the effect of MH30 (an antisprouting agent) on storage durability.

METHODS AND MATERIALS

Soils. Onion trials were conducted at the Valley Laboratory in Windsor on Merrimac sandy loam, a sandy terrace soil with somewhat limited moisture holding capacity, and at Lockwood Farm in Mt. Carmel on Cheshire fine sandy loam, a well drained loamy upland soil with moderate moisture holding capacity.

Cultivars. Seeds were obtained from several domestic and foreign seed suppliers. Yellow, red, and white cultivars of Spanish and storage types were included. They are grouped as follows:

YELLOW SPANISH—Ailsa Craig, Burrell's Yellow Valencia, Daytona, Gringo, Hybrid Big Mac, Oro Grande, Ringmaker, Riverside, Sweet Spanish Colorado No. 6, Valiant, Yellow Sweet Spanish

RED SPANISH—Big Red

WHITE SPANISH—Snow White, White Keeper, White Sweet Spanish

YELLOW STORAGE—Copra, Corona, Early Yellow Globe, Granite, Prince, Sweet Sandwich, Wolverine

RED STORAGE—Benny's Red, Red Man

Culture. Three rows of seed were sown March 6-9 in shallow trays, 21x11x2.5 inches, and in each unit of 162-pack propagation trays, 1x1.5 inches, all filled with Promix

BX in a greenhouse maintained at 50-70F. The seedlings in the trays were lightly thinned to avoid overcrowding after reaching 1-1.5 inches height. The seedlings in the propagation trays were also thinned to one seedling/plug. After 5 weeks, the seedlings were moved to a cold frame for hardening 14 days before planting in the field. Water soluble 20-20-20 fertilizer (1 tbsp/gal) was added to the seedlings 1 week before transplanting. On May 6-12, the seedlings were transplanted at both sites in paired 30-foot rows 12 inches apart with 24 inches between cultivars. In one row, seedlings with bare roots were transplanted from flats, and the other row transplanted with plugs from the propagation trays. Spanish onion transplants were set 6 inches apart within rows; storage onions, 4 inches apart. At Mt. Carmel, the transplants were irrigated about 1 week after planting, and at Windsor, 5 weeks.

Fertilizer amendments. The soils were fertilized with 1200 lb/A 10-10-10 and limed to attain a pH of 6.5 before planting. In early June, the crops at each site were sidedressed with 90 lb/A ammonium nitrate at the 5-leaf stage. At Windsor, after heavy rains leached the soil in early June, an additional 45 lb/A ammonium nitrate was applied mid June and again in late June. Total fertilization supplied about 180 lbN/A to the growing crop at Windsor and 150 lbN/A at Mt. Carmel.

Weed and insect control. At Mt. Carmel, weeds were controlled with Dacthal 75W (10 lb/A) applied immediately after transplanting. Weeds that emerged between transplanting and the 3-leaf stage of growth were controlled with Goal 1.6E (3 oz/A). At Windsor, weeds were controlled with light applications of Goal 1.6E (3 oz/A) up to July 1.

Root maggots were controlled with Lorsban 4E (1.1 oz/1000 ft of row), applied as a soil-drench, immediately following transplanting. Foliar damage by onion thrips was controlled with Diazinon AG500 (1 pt/A).

Harvest and storage. Maleic hydrazide (MH30 at 2.5 lb/A), an antisprouting agent, was applied to green plants in one-half of each row as they began to topple. After half of all plants toppled; those remaining erect were bent over. After the tops began to wither, the bulbs were uprooted and air dried for 7-10 days. The bulbs were weighed and graded by diameter according to USDA and commercial standards as follows:

Colossal	4.0"+
Jumbo	3.0-4.5"
Medium	2.0-3.5"
Small	1.0-2.25"

After weighing and grading all onions, 25 bulbs treated with MH30 and 25 untreated bulbs from each cultivar were randomly sampled, placed in wire baskets, and stored at 32F and 70% humidity. After 20 weeks, cold storage was terminated and the temperature rose to 55F. After 3 weeks at 55F, losses due to rotting and sprouting were measured.

YIELDS

Spanish onions. At Windsor, the average yield of 15 cultivars was 669 50-lb bags/A for bare-rooted transplants compared to 556 50-lb bags/A for transplanted plugs (Table 1). Higher yield from bare-rooted transplants compared to transplanted plugs was due to increased average bulb weight (13.0 vs 11.7 oz) and average percent harvested (69 vs 63). Yield of bare-rooted Daytona and Oro Grande exceeded 1000 50-lb bags/A by virtue of heavy bulbs and high percentage harvested. Yield of Gringo, Hybrid Big Mac, Valiant, and Snow White were above the national average of 720 50-lb bags/A (USDA 1990). For plug transplants, yield of Oro Grande, Daytona, Valiant, Hybrid Big Mac, and Ailsa Craig also exceeded the national average. Among the white cultivars, Snow White had the greatest yield for bare-rooted and plug transplants. White Keeper neared the national average for bare-rooted transplants only.

At Mt. Carmel, the average yield of 15 cultivars was 368 50-lb bags/A for bare-rooted transplants compared to 331 50-lb bags/A for transplanted plugs (Table 2). The higher average yield for bare-rooted transplants compared to transplanted plugs was due to heavier bulbs (8.8. vs 8.0 oz). The higher average yield at Windsor, compared to Mt. Carmel, for bare-rooted transplants and plugs is due to a 43-48% increase in bulb weight and a 6-12% increase in bulbs harvested.

Although Valiant and Oro Grande had the highest yield from bare-rooted transplants and plugs, they were below the national average. Among the white cultivars, White Sweet Spanish had the greatest yield from bare-rooted transplants and plugs, but was well below the national average.

Storage onions. At Windsor, the average yield of nine cultivars was 740 50-lb bags/A for bare-rooted transplants compared to 669 50-lb bags/A for transplanted plugs (Table 1). The higher yield of bare-rooted transplants compared to plugs was due to increased average bulb weight (9.2 vs 8.6 oz). Yield of bare-rooted Corona and Prince exceeded 1000 50-lb bags/A. Yield of Copra, Wolverine, Early Yellow Globe, and Sweet Sandwich also exceeded the national average of 720 50-lb bags/A because of a high percentage of marketable bulbs.

For plug transplants, yield of Corona exceeded 1000 50-lb bags/A; Prince, Copra, and Sweet Sandwich exceeded the national average. Marketable bulbs ranged between 80-90% for these cultivars. Bulb weight of the red cultivars, Benny's Red and Red Man, was average among all storage cultivars, but only 32% of the bulbs from bare-rooted and plug transplants were marketable.

The average yield of bare-rooted storage cultivars was 11% greater than bare-rooted Spanish cultivars and 20% greater for storage cultivars than Spanish cultivars grown from plugs. Although bulb weight of Spanish cultivars is 40% greater than bulb weight of storage cultivars, higher

Table 1. Yield of Spanish and storage onions grown from bare-rooted and plug transplants at Windsor, 1992.

	Harvested %		Avg bulb wt. oz		50-lb bags No./A	
	Bare Rooted	Plugs	Bare Rooted	Plugs	Bare Rooted	Plugs
SPANISH TYPES						
Ailsa Craig	75	60	18.4	17.3	1003	752
Daytona	93	82	15.8	13.6	1071	812
Gringo	65	60	16.6	13.8	786	600
Hyb. Big Mac	80	77	14.4	13.8	840	772
Oro Grande	92	90	15.8	15.2	1054	989
Ringmaker	68	68	13.6	13.4	673	661
Riverside	53	67	13.6	10.4	521	510
Sw. Sp. Colorado #6	92	78	7.4	9.9	495	558
Valiant	92	100	12.5	10.6	832	764
Yellow Sweet Sp.	75	68	11.8	9.3	648	461
Yel. Valencia	48	30	6.9	5.8	238	126
Big Red	27	23	9.1	8.3	178	138
Snow White	80	60	13.0	11.8	755	515
White Keeper	72	53	13.0	12.0	680	468
White Sweet Sp.	28	27	12.6	10.9	256	213
STORAGE TYPES						
Copra	93	94	8.8	8.3	891	845
Corona	99	98	9.6	9.8	1043	1027
Early Yellow Globe	84	71	8.5	9.0	834	696
Granite	61	72	8.6	7.8	580	613
Prince	98	94	9.8	9.1	1039	932
Sweet Sandwich	80	71	8.5	9.8	801	755
Wolverine	81	67	9.8	7.7	862	567
Benny's Red	33	34	9.8	8.5	350	313
Red Man	31	32	9.1	7.8	309	273

average yield of storage cultivars is attained because of a higher planting density than for Spanish cultivars (87,120 vs 58,080 plants/A).

At Mt. Carmel, the average yield of nine cultivars was 536 50-lb bags/A for bare-rooted transplants compared to 449 50-lb bags/A for transplanted plugs (Table 2). The higher yield of bare-rooted transplants compared to plugs was due to increased average bulb weight (6.9 vs 6.0 oz). Yield of bare-rooted Prince, Copra, and Red Man exceeded 630 50-lb bags/A, but none exceeded the national average. Copra had the greatest percentage of marketable bulbs, and Prince had the highest bulb weight. For plug transplants, yield of Prince and Copra exceeded 500 50-lb bags/A.

Average yield of bare-rooted storage onions was 46% greater than for bare-rooted Spanish onions and 36% greater for plug transplants due to greater planting density.

SIZE GRADES

Spanish onions. At Windsor, fully 80% of all Spanish onions, grown from bare-rooted transplants, exceeded 3 inches diameter and were graded jumbo (76%) or colossal (4%) compared to 73% for onions grown from plugs (jumbo 70%, colossal 3%) (Table 3). Ailsa Craig and Oro Grande had the greatest yield of colossal size for bare-rooted transplants and plugs. Yield of jumbo onions exceeded 85% in bare-rooted transplants of Daytona, Gringo, Oro Grande, Ringmaker, Riverside, and White Keeper. For plug transplants, Daytona, Gringo, Hybrid Big Mac, and Oro Grande exceeded 85% jumbo size.

At Mt. Carmel, 47% of all Spanish onions grown from bare-rooted transplants exceeded 3 inches diameter and were graded jumbo (45%) and colossal (2%) compared to 38% jumbo size for onions grown from plugs (Table 4). Ailsa Craig had the greatest yield of colossal size. No cultivars yielded at least 85% jumbo size. Yield of jumbo onions was greatest for Hybrid Big Mac and Snow White. At Mt. Carmel, the predominant grade size was jumbo for bare-rooted transplants and medium for plug transplants.

Storage onions. At Windsor, 56% of all storage onions, grown from bare-rooted transplants, attained jumbo size compared to 51% for transplanted plugs (Table 3). Prince had the greatest yield of jumbo size for both bare-rooted and plug transplants. The yield of Corona, Benny's Red, and Red Man exceeded 64% jumbo size for bare-rooted transplants. Corona and Sweet Sandwich also had high yields of jumbo size for plug transplants. Despite a few cultivars with a high percentage of jumbo sizes, the dominant size for storage onions at Windsor was medium.

At Mt. Carmel, 33% of all storage onions grown from bare-rooted transplants attained jumbo size compared to 20% for transplanted plugs (Table 4). Medium sizes dominated the onions grown from both bare-rooted and plug transplants. Prince had the highest yield of jumbo onions for both types

of transplants but the yield of jumbo size was 35-65% less than Windsor.

STORAGE DURABILITY

Stored onions are the mainstay of winter and early spring sales. Although Spanish onions are generally sold soon after harvest, they can be kept 1-3 months. Under proper conditions of temperature and humidity, some storage onions can be stored nearly a year. In these trials, both types of onions were placed in cold storage for 21-29 weeks and then at 55F for an additional 3 weeks. Table 5 shows the percentages of storage losses for MH30 treated and untreated onions. Rotted bulbs include losses from heart rot and bulbs whose outer scales were soft to the touch but whose inner scales were sound. Sprouted bulbs were those whose necks were breached by newly elongating leaves.

Storage losses were excessive for the entire crop of Spanish onions. Fully 80% of all Spanish onions were lost in storage (28% rotted; 52% sprouted). For storage onions, 44% were lost in storage (20% rotted; 24% sprouted). Treatment of Spanish onion bulbs with MH30 had little effect on storage durability. Sprouting loss of treated bulbs was 54% compared to 50% of untreated bulbs. For storage onions, MH30 treatment improved storage durability. Only 18% of MH30 treated bulbs sprouted as compared to 30% of untreated bulbs.

Despite excessive losses of most Spanish onions, the cultivar Daytona had outstanding durability. Losses of both treated and untreated bulbs were only 16%. Their thick, hard outer scales resisted infection and the bulbs remained dormant for 7 months. Oro Grande and Valiant had fair durability with 52-56% losses. Their dormancy period, however, is less than 7 months. All other cultivars had poor durability by virtue of excessive rotting or sprouting. Their durability is probably closer to 1-3 months rather than 7 months.

Among the storage cultivars, Copra and Wolverine had the fewest losses and responded well to the MH30 treatment. Their hard outer scales resisted infection. Granite had the best response to MH30 treatment with 6-fold less sprouting in MH30-treated bulbs.

MANAGEMENT STRATEGIES

Site selection. The data from Tables 1 and 2 suggest that light sandy soils produce greater yields of both Spanish and storage onions than heavier loamy soils. This is consistent with earlier observations at the same sites (Hill 1992). On sandy soils average yield of onions was greater than loamy soils for both bare-rooted and plug transplants. Although yield on loamy soils can be improved 10-15% by addition of 1-inch leaf mold, it seldom reaches the national average of 720 50-lb bags/A.

Table 2. Yield of Spanish and storage onions grown from bare-rooted and plug transplants at Mt. Carmel, 1992.

	Harvested %		Avg bulb wt. oz		50-lb bags No./A	
	Bare Rooted	Plugs	Bare Rooted	Plugs	Bare Rooted	Plugs
SPANISH TYPES						
Ailsa Craig	52	23	10.2	10.2	387	170
Daytona	57	75	7.7	7.5	315	409
Gringo	47	68	8.3	9.6	284	471
Hyb. Big Mac	62	55	10.4	8.6	470	343
Oro Grande	63	78	11.0	10.2	507	581
Ringmaker	52	65	9.3	8.6	348	404
Riverside	53	50	9.1	6.1	352	220
Sweet Sp. Colorado #6	70	67	6.6	8.3	330	402
Valiant	87	88	11.0	8.3	696	530
Yellow Sweet Sp.	68	72	8.8	7.4	433	382
Yel. Valencia	60	53	7.0	6.1	305	237
Big Red	52	52	6.7	6.4	207	239
Snow White	32	27	9.0	9.1	258	178
White Keeper	53	38	7.5	7.4	291	169
White Sweet Sp.	48	37	9.8	8.6	342	232
STORAGE TYPES						
Copra	93	83	6.7	5.8	680	519
Corona	83	84	6.4	5.1	580	474
Early Yellow Globe	46	62	6.4	6.1	279	410
Granite	82	62	5.6	6.1	496	405
Prince	76	83	8.3	6.1	695	546
Sweet Sandwich	59	57	7.5	6.4	484	394
Wolverine	73	76	6.4	5.8	505	481
Benny's Red	60	58	7.2	5.8	475	368
Red Man	74	62	7.8	6.6	631	440

Table 3. Size grades of Spanish and storage onions grown from bare-rooted and plug transplants at Windsor, 1992.

	Bare Rooted				Plugs			
	4"+ %	3-4" %	2-3" %	1-2" %	4"+ %	3-4" %	2-3" %	1-2" %
SPANISH TYPES								
Ailsa Craig	22	71	7	-	17	83	-	-
Daytona	5	88	7	-	2	88	10	-
Gringo	8	90	2	-	8	86	6	-
Hybrid Big Mac	8	84	8	-	9	85	6	-
Oro Grande	13	87	-	-	9	91	-	-
Ringmaker	-	95	5	-	5	80	15	-
Riverside	9	85	6	-	-	60	40	-
Sweet Sp. Colorado #6	-	53	47	-	-	68	32	-
Valiant	-	62	38	-	-	69	31	-
Yellow Sweet Sp.	-	80	20	-	-	63	37	-
Yel. Valencia	-	52	48	-	-	11	72	17
Big Red	-	38	62	-	-	29	71	-
Snow White	2	77	21	-	-	69	31	-
White Keeper	-	91	9	-	-	84	16	-
White Sweet Sp.	-	82	18	-	-	75	25	-
STORAGE TYPES								
Copra	-	54	46	-	-	51	49	-
Corona	-	64	36	-	-	73	26	-
Early Yel. Globe	-	32	67	1	-	52	42	6
Granite	-	38	62	-	-	22	78	-
Prince	-	73	27	-	-	76	24	-
Sweet Sandwich	-	51	49	-	-	66	34	-
Wolverine	-	56	44	-	-	25	75	-
Benny's Red	-	73	27	-	-	48	45	7
Red Man	-	64	36	-	-	45	52	3

Table 4. Size grades of Spanish and storage onions grown from bare-rooted and plug transplants at Mt. Carmel, 1992.

	Bare Rooted				Plugs			
	4"+ %	3-4" %	2-3" %	1-2" %	4"+ %	3-4" %	2-3" %	1-2" %
SPANISH TYPES								
Ailsa Craig	13	36	45	6	-	36	57	7
Daytona	-	38	38	24	-	40	40	20
Gringo	-	54	21	25	2	47	29	22
Hybrid Big Mac	3	59	32	6	-	45	52	3
Oro Grande	3	55	39	3	2	51	42	5
Ringmaker	-	52	45	3	-	52	33	15
Riverside	3	53	28	16	-	17	67	16
Sweet Sp. Colorado #6	-	36	26	38	2	45	33	20
Valiant	-	56	44	-	-	36	56	8
Yellow Sweet Sp.	3	41	51	5	-	33	58	9
Yel. Valencia	3	28	50	19	-	22	62	16
Big Red	-	19	71	10	-	29	55	16
Snow White	-	63	21	16	-	38	56	6
White Keeper	6	44	31	19	-	35	56	9
White Sweet Sp.	-	48	38	14	-	36	55	9
STORAGE TYPES								
Copra	-	30	61	9	-	12	80	8
Corona	-	32	52	16	-	21	59	20
Early Yel. Globe	-	29	51	20	-	18	59	23
Granite	-	28	57	15	-	11	71	18
Prince	-	48	46	6	-	27	55	18
Sweet Sandwich	-	40	45	15	-	25	53	22
Wolverine	-	26	59	15	-	19	63	18
Benny's Red	-	33	58	9	-	19	56	25
Red Man	-	36	54	10	-	27	57	16

Table 5. Storage losses of Spanish and storage onions stored at 34F and 70% relative humidity for 21 to 29 weeks and then at 55F for 3 weeks.

	Cold Storage weeks	MH 30 Treated Rotted %	MH 30 Treated Sprouted %	Untreated Rotted %	Untreated Sprouted %
SPANISH TYPES*					
Ailsa Craig	27	76	24	64	24
Daytona	25	12	4	12	4
Gringo	26	16	84	52	36
Hybrid Big Mac	26	48	44	20	64
Oro Grande	26	28	40	24	32
Ringmaker	29	16	68	28	72
Riverside	29	20	80	12	88
Sweet Sp. Colorado #6	25	24	68	12	80
Valiant	29	8	44	12	40
Yel. Sweet Spanish	29	32	52	44	52
Snow White	27	20	52	44	48
White Keeper	27	28	56	44	28
White Sweet Sp.	25	16	80	8	84
STORAGE TYPES					
Copra	25	4	0	4	12
Corona	25	16	28	0	20
Early Yel. Globe	28	24	12	36	12
Granite	22	24	8	12	48
Prince	22	24	12	20	20
Sweet Sandwich	22	28	32	8	36
Wolverine	21	0	12	4	20
Benny's Red	21	32	24	32	56
Red Man	21	60	40	16	36

* Yellow Valencia and Big Red had insufficient sample for storage.

Fertilization and irrigation. Maximum yield of onions requires optimum nitrogen and moisture supplies, especially during bulb formation, which begins when daylength reaches 15 hours for long-day cultivars (Splittstoesser 1979). Initial preplant application of 1200 lb/A 10-10-10 fertilizer (120 lb N/A) followed by a sidedressing with 90 lb/A ammonium nitrate (30 lb N/A) at the 5-leaf stage in early June should supply adequate nitrogen. After heavy rains in June, which may leach earlier applications of nitrogen, sandy soils may require additional light applications of ammonium nitrate (45 lb/A) in mid to late June. Soil tests can verify depletion of nitrogen.

Onions should receive at least 1 inch of water each week from rainfall or irrigation from transplanting through the completion of bulb formation.

Bare-rooted vs plug transplants. From Tables 1 and 2, it is obvious that yield of bare-rooted transplants consistently exceeded the yield from transplanted plugs. Although plug transplants are easier to plant, early growth is hindered by development of a small root ball bound by the container wall. By the time roots escaped the root ball into the surrounding soil, top growth was delayed compared to bare-rooted transplants. At the time of bulb formation, the smaller plants grown from the plugs could only produce smaller bulbs. Larger plugs may have prevented the balling of roots, but transplanting them would have been more difficult. Although transplant shock in bare-rooted transplants caused some delay in growth, the roots became established in a few days, and unimpeded growth ensued.

Harvest and storage. Mature bulbs were harvested and field dried for about 10 days. Preferably, they should be protected from the sun to prevent scalding. If left in the field too long, cultivars with short dormancy periods may sprout in the field or shortly after they are placed in storage. Alternatively, anti-sprouting agents, such as maleic hydrazide can be sprayed on the crop a few days before harvest while the plants are still green. The agent is absorbed by the leaves and translocated to the bulb. Our tests have shown, however, the MH30 had little effect on the sprouting of Spanish onion cultivars. This is probably due to the shorter dormancy of Spanish onions compared to storage onions. The percent of marketable bulbs of storage onions, after 21-25 weeks storage, was improved 12-40% by application of MH30. Bulbs should be stored at 34F and a relative humidity of 50-70% to maintain dormancy.

Cultivar selection. Because onions are harvested all at once, most are stored for future winter and spring sales. Thus, selection of cultivars is based not only on yield but also durability under protracted cold storage and return to room temperature. Size distribution is also important because colossal and jumbo sizes are sold at a premium over medium and mixed sizes. Among the yellow Spanish onions, Daytona provided the greatest yield (1071 50-lb bags/A), a high

percentage of colossal and jumbo sizes (93%), and a storage durability that exceeded 7 months. This cultivar is well-suited for winter and early spring sales. Yield of Oro Grande and Ailsa Craig also exceeded 1000 50-lb bags/A and 93-100% colossal and jumbo sizes. Oro Grande, however, had over 50% loss after 7 months storage, thus it is best suited to fall and winter sales. Ailsa Craig has thin outer scales and is easily bruised during harvest and sorting. It is best suited for direct fall sales without storage. Gringo, Hybrid Big Mac, and Valiant also, had over 780 50-lb bags/A, a high percentage of colossal and jumbo sizes, but relatively short durability in storage. These cultivars are best suited to fall and winter sales.

Among the white Spanish cultivars, Snow White and White Keeper had the greatest yield, the highest percentage of jumbo size, but low storage durability. These cultivars are best suited for direct fall or early winter sales.

Among the yellow storage onion cultivars, the yield of Corona and Prince exceeded 1000 50-lb bags/A. These cultivars also had the highest percentage of jumbo size grown from bare-rooted or plug transplants. Since storage losses after 7 months for both cultivars were over 35%, they would be best suited for fall and winter sales. Although the yields of Copra and Wolverine were somewhat less than Corona and Prince, they are the cultivars of choice for long term storage durability. They are best suited for late winter and early spring sales.

Among the red storage onion cultivars, Benny's Red is preferred. Although yield is somewhat low, the percentage of jumbo size is high. Short storage durability, however, limits it to direct fall or early winter sales.

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